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INFECTIOUS HEPATITIS IN CANADIAN FORCES PERSONNEL(U)  
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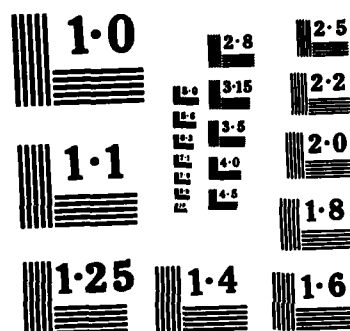
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CONTRACT REPORT

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INFECTIOUS HEPATITIS IN CANADIAN FORCES PERSONNEL

1985

by

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EXECUTIVE SUMMARY

1. This study was established to study the prevalence of infectious Hepatitis (Hepatitis A) antibody (anti-HAV) in several groups of CF personnel in order to assist the Surgeon General in assessing the hazard of the disease and to indicate the effectiveness of conventional immune globulin administration for prevention of infection among personnel posted in areas of high risk. In addition, it is expected that a vaccine for Hepatitis A will become available in the near future. The Surgeon General also requires guidance regarding the requirement for universal or selective immunization of personnel with this vaccine.

2. Although not marked by high levels of death (less than 1%), infectious Hepatitis is capable of causing serious illness which is characterized by fever, nausea, intestinal upset and jaundice. The disease is generally spread through fecal contamination of food and water and is often an indication of poor sanitation and personal hygiene and is therefore a major risk to military populations operating under field conditions. In addition, UN-related duties frequently cause CF personnel to be posted in areas of high incidence of this disease such as Egypt, Cyprus and Syria.

3. A total of 4248 CF personnel aged 17-53 years were examined in the present study for the presence of anti-Hepatitis A antibody. The groups examined were as follows: recruits from CFB Cornwallis (1851); recruits from CFB St. Jean (185); subjects stationed at CFS Alert (72); three separate groups of personnel posted in Cyprus (1379); personnel rotated through Golan Heights/Syria (438) and the crew of HMCS Margaree (251) during NATO '83 exercises.

4. An overall rate of 23.6% for presence of anti-Hepatitis A antibody was observed.

5. The study of recruits from CFB Cornwallis revealed an overall rate of 18% with one case of seroconversion. Recruits who could be identified as hailing from rural areas had a rate of 25.9% as compared to 16.7% in those from urban areas. In addition, a substantially higher incidence of anti-HA was noted in recruits with francophone surnames. The study at CFB St. Jean did not confirm this to be a general trend since the rate in that population sample was substantially lower (9.7%) than at CFB Cornwallis. The higher rate among francophones at CFB Cornwallis was concluded to be due to rural/urban differences.

6. Troops posted to Cyprus exhibited a previous exposure rate of approximately 26%, with the rate being significantly higher with increased age.

7. A positive rate of approximately 39% was noted in troops stationed in the Golan Heights. Two seroconversions were observed in this group.

8. The CFS Alert population tested showed a positive rate of about 39%, again reflecting the higher average age of this population.

9. The study was expanded to include the crew of HMCS Margaree due to an outbreak of Hepatitis B which occurred in 1983. Of the crew, 31.5% were positive for anti-HAV antibody and 10% for antibodies to Hepatitis B core antibody (HBcAb). In this population as well, there was a strong positive correlation between age and the rate of anti-HAV. With regard to Hepatitis B, evidence of core antibody was most prevalent in the lower ranks being 25% among Leading Seamen and 31% among MCpl as compared to 10% for the crew as a whole. Tattoos were shown to possibly be related to a higher incidence of Hepatitis B core antibody.

10. In general, the rate of CF personnel positive for anti HAab is significantly higher than the general population although it is similar

to that observed in other studies on military populations in other countries. Studies with recruits and younger CF populations indicated that personnel from the Atlantic provinces had a generally higher rate of anti-HAV antibody than those from the other major geographical areas of the country.

11. Throughout the study, there was an almost perfect correlation between increasing age and the level of antibodies to Hepatitis A. Levels of these antibodies were also noted to be much higher among personnel from rural areas which emphasizes the importance of sanitation and personal hygiene in the prevention of the spread of this disease.

12. Pre-exposure immunization of personnel posted to Cyprus and Syria with immune serum globulin appeared to be successful in preventing both clinical and subclinical infections of Hepatitis A. Although use of this sera apparently led to measurable increases in anti-HAV antibody levels in 65% of personnel, the contractor makes a strong case for more quantitative studies of this aspect. A decision on this recommendation is required from DPM.

13. The contractor further recommends that the study on Hepatitis B in the crew of HMCS Margaree be expanded to measure the levels of antibody to the surface components of this virus in order to compare these with the core antibody levels determined in this study. Since the sera are already on hand and stored by the contractor, this small study should be considered seriously by DPM.

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CONTRACT NUMBER: 01SG.97702-R-2-6170  
8SG82-00092

TITLE: Infectious Hepatitis in Canadian Forces Personnel.

OBJECTIVE

To study the prevalence of infectious Hepatitis (Hepatitis A) in various groups of Canadian Forces Personnel, in order to assist the Surgeon General in assessing the hazard of this disease when an appropriate vaccine becomes available.

BACKGROUND

Hepatitis A is a highly contagious debilitating disease which is a major worldwide public health problem. Incidence varies from country to country, with the disease being epidemic in areas where sanitation practices are poor. The activities of the Canadian Forces may take them, on short notice, into epidemic areas. In addition, during periods of military tension or alert and during wartime, pressures on troops may be such that hygiene practices deteriorate exposing personnel to an increased hazard of this disease.

STATEMENT OF WORK (as stated in contract)

The contractor will carry out the following in consultation with the Preventive Medicine Section, Defence Research Establishment Suffield (DRES), Ralston, Alberta; Directorate of Preventive Medicine, National Defence Headquarters, Ottawa, Ontario, and the Base Surgeon, CFB St. Jean.

1. Commencing February 1, 1983, sera will be collected from representa-

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tive recruits at CFB St. Jean upon entry into training and on completion. These will be examined for seroconversion. In the event of evidence of seroconversion, a larger number of serum samples may be required from each recruit in order that time of seroconversion can be pin-pointed and the nature of the immunoglobulin response investigated.

2. Commencing February 1, 1983, sera will be collected from each Canadian Forces man posted on U.N. duty to Cyprus or Syria (Golan Heights). Sera will be collected from each upon his return from this duty. Sera will be examined for presence of antibody to Hepatitis A and seroconversion during his posting. In order to determine the effectiveness of hyperimmune serum which is given to each man prior to posting, each of the sera will be titred for specific Hepatitis A antibody. This will enable the determination of whether or not these men have been infected subclinically with infectious Hepatitis.

ADDITIONAL INFORMATION

1. Methods of assay of samples shall be determined by the contractor and approved by the Scientific Authority. Should the Base Surgeon raise objections, modifications may occur provided approval of the Scientific Authority is obtained.

2. The contractor is responsible for providing all supplies such as vacutainers, transport containers, etc. to CFB St. Jean and other bases involved. In addition, detailed instructions pertaining to the method of obtaining samples, storage and transport of samples shall be provided by the contractor.

3. DRES will provide the radioimmunoassay reagents required to carry out these tests.

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MATERIALS AND METHODS

Paired blood serum samples were drawn from 4176 Canadian Forces personnel between July 1981 and July 1984, and from 72 subjects stationed at CFS Alert between November 1977 and March 1978. Six different groups of personnel were included in the study: recruits at CFB Cornwallis (1851) and at CFB St. Jean (185), three separate groups of men stationed with the UN force in Cyprus (total 1379), men rotated through Golan Heights/Syria (438), and the crew of HMCS Margaree (251) during NATO '83 exercises, as well as the control group from CFS Alert. The information on each of the groups is outlined in Table I and below.

1. CFB Cornwallis:

There were 861 males and 513 females included for a total of 1372 paired sera, the first taken at the beginning of basic training and the second at the end, and 479 unpaired sera, two of which were taken at the end of the course indicating that these individuals had been available when the initial blood samples were drawn.

The blood was allowed to clot and the serum removed at Cornwallis and then shipped immediately to Halifax. On its arrival at this laboratory, the serum was frozen at  $-20^{\circ}\text{C}$  until the second specimen arrived. At that time, both samples were tested for antibodies to Hepatitis A (anti-HAV) using Abbott HAVAB radioimmunoassay kits and a Packard Gamma Scintillation Spectrometer Model 5375. Results were tabulated, keypunched, and sent to the Department of Epidemiology and Community Health of Dalhousie University for statistical analysis, using the SPSS (Statistical Package for the Social Sciences) and a Cyher 170-730 computer, with regard to age, sex, place of residence at enlistment, province of birth, change in province or country since birth, rural/urban home, length of course, and military occupation.

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2. CFB St. Jean

Paired sera taken at intervals ranging from 4 to 7 weeks were received from 154 males and 31 females during basic training. The sera arrived in the frozen state from the Bureau of Biologics Virus Laboratory, Tunney's Pasture, Ottawa, in August 1983. The paired specimens were tested as outlined above, and the results statistically analysed at the Dalhousie Department of Epidemiology and Community Health with regard to age, sex, geographic origin, length of course, and military occupation.

3. Cyprus

Three groups of men totalling 1379 were included in this test group. The blood samples were drawn prior to departure for service with NATO forces in Cyprus and following repatriation, with the first samples' being stored at -20°C in our laboratory until the arrival of the second.

The first group of 392 personnel was bled 28 August 1981 at CFB Valcartier. Of these, only 160 generated a second sample on repatriation leaving 232 unpaired samples, 41 being post-duty only.

The second group, from CFB Winnipeg, was bled 28 August 1982. Their second sera were taken 29 April 1983 and prepared at Cadham Provincial Laboratories in Winnipeg for shipment to our lab packed in dry ice. In this group there were 502 subjects, 315 with paired sera and 187 singles, 60 of which were taken following repatriation.

The third group of subjects, again from CFB Valcartier, was bled 18 January 1983 and followed up in October 1983. There were 323 paired and 162 single specimens in this group, 31 of which were drawn on repatriation. All these samples were tested for anti-HAV as previously stated, and the

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statistical analysis was carried out with respect to age, military occupation (where available), and area of origin.

4. Golan Heights/Syria

Between January 4, 1982 and November 17, 1983, 438 new arrivals on rotation at CANLOG/Camp Ziounia were bled and the serum stored at -20°C on location. Of these, 361 were paired, 70 singles taken before duty, and 7 before repatriation. Immediately prior to repatriation, each subject was again bled, and the serum frozen. Periodically, sera were flown, frozen, via military channels to Halifax for testing. Again, paired samples were tested simultaneously.

When the samples consistently produced odd test results, dilutions were made of positive specimens and the titre (the reciprocal of the dilution factor equal to the cutoff reading) of anti-HAV determined.

Statistical analysis of the test results were carried out for age, geographic origin, weeks elapsed between first and second specimen, home unit, area of service, and the number of days between immune serum globulin (ISG) administration and the first bleeding.

In an attempt to determine what effect, if any, the administration of immune serum globulin (ISG) had on the serum levels of anti-HAV, comparisons were made of the counts registered per minute in paired specimens during ABBOTT HAVAB-RIA testing on a sample of 130 cases. Seroconversions and equivocal results were excluded from this sample group, which were taken from subjects #1 to #70 and #356 to #477 inclusive.

5. CFS Alert

Serum samples drawn between November 1977 and March 1978 from 72

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subjects stationed at CFS Alert were forwarded to this laboratory to be used as controls representing an older group of personnel than the recruits. Seventy persons presented 2 or more specimens and 2 were unpaired. There are 2 unidentified samples which may or may not be matched. These sera were tested for anti-HAV by the ABBOTT HAVAB radioimmunoassay system. Because the only information received was the bleeding date for each sample, no computerized statistical analysis was carried out for this group.

6. HMCS Margaree

Sera were obtained initially from 242 crewmembers of HMCS Margaree, all but one drawn 19 August 1983. These were prepared and forwarded to us in the liquid state. In December, 1983, samples were received from 9 additional crewmembers. Storage in this laboratory was at -20°C and all samples were tested as soon as possible for anti-HAV, Hepatitis B surface antigen (HBsAg), and antibodies to Hepatitis B core antigen (HBcAb) using enzyme immunoassay kits from ABBOTT (HAVAB, Auszyme II, and Corzyme). Followup bleeding was scheduled for mid-November, 1983, but as of this date sera are still arriving. Specimens are pending on 19 of the original crewmembers, 11 of whom have been released from Armed Services leaving 8 to complete the followup study.

Information received with the second specimens allowed analysis with regard to age, years of military service, geographical origins, previous service outside Canada and visits to Portugal/Mediterranean ports, rank, military occupation, and whether or not each was tattooed.

RESULTS

The testing of 4176 Canadian Forces personnel for antibodies to Hepatitis A virus yielded 987 positive subjects, or an overall rate of 23.6% among a group with an age range of 17 to 53 years. The results of testing

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and the average age for each group are summarized in Table II.

The crew of HMCS Margaree, tested in addition for Hepatitis B surface antigen and antibodies to Hepatitis B core antigen, yielded one resolving case of Hepatitis B and one apparent carrier, as well as an overall core antibody level of 10%.

The tests used in the primary screening of all specimens covered by this contract, as well as the immediately preceding contract, are outlined in Table III. Additionally, several hundred test units were used in determining antibody titers and in rechecking tests that yielded seroconversions or otherwise questionable results.

Observations for each group, individually, are given below.

1. CFB Cornwallis

Of the 1851 persons included in the study, 333 (18.0%) were positive for antibodies to Hepatitis A. There was no difference in the prevalence rates for males and females. One subject, a 17 year-old radio operator from Ontario, was negative for anti-HAV in the first sample and positive in the second.

The ages of the subjects in this study ranged from 17 to 30 years, with 95% falling between 17 and 23. The average age of the males in this study was 19.2 years, and that of the females, 19.4 years. The correlation between age and anti-HAV in this group was on the verge of being positive ( $p=0.06$ ), but a lack of subjects in the upper age brackets made a valid comparison impossible.

The initial requirements for the study did not include data on the

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from Cornwallis to the Margaree.

Table XIV shows the prevalence of the various markers for Hepatitis B in immune subjects. A recently published article in Canada Diseases Weekly Report (6) showed the level of anti-surface to be much more prevalent in selected Canadian Forces health care personnel than anti-core. This was not the finding in the other three studies (4, 5, 7) that we have found in the literature. As we already have half of the testing completed (core antibodies), we are in an excellent position to add valuable information to this matter by testing the sera at hand from Cornwallis and the Margaree for antibodies to Hepatitis B surface antigens.

In examining the results for seroconversions from negative to positive for anti-HAV, it becomes apparent that the risk of acquiring an infection of Hepatitis A remains small under the present practise of administering immune serum globulin to personnel entering areas where Hepatitis A is endemic, and of repeating the procedure if the tour of duty is extended beyond the expected six months. It is possible that the use of a vaccine may well prove cost-effective in the future, especially in the case of personnel who spend greater lengths of time in high-risk areas of the world, but there is also the possibility that the effectiveness of the ISG lasts far longer than has been presumed (2), and further studies of the mechanism of the immunity conferred by ISG are needed to throw some light on the matter.

#### REFERENCES

1. Weiland, O. Hepatitis A: Aspects on prophylaxis and a comparison with Hepatitis B and Hepatitis non-A, non-B on epidemiology and prognosis. Tryckeri Balder AB, Stockholm, 1981.
2. Braithwaite, Maj M.G. Prophylaxis of Hepatitis A with immune

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The study of the crew of HMCS Margaree during NATO 1983 exercises has been interesting, as well as an exercise in persistence. As of mid-July 1984, the blood samples expected in mid-November 1983 were still slowly arriving, and testing remains to be done on those samples. As all are followup specimens, the statistical analysis was done using the first sample only and the data received with the second sample when it arrived. The remaining sera will be tested and any changes in status will be reported at a later date. There are only 8 samples outstanding from subjects still active in military service, but the information requested is still missing for a number of men from whom we have already received a second serum sample.

As there were no seroconversions for Hepatitis A, that factor did not arouse much interest. The interesting areas appeared when analysis of anti-HAV by military occupation showed certain groups to have unusually high occurrences of antibody. The reasons for these outstanding groups are unknown. One asks if it may be due to what one researcher has called the "cohort effect". When examining the relationship of military occupation to the presence of tattoos, the relationship became quite noticeable. The presence of antibodies to Hepatitis B tended to be higher in tattooed than in non-tattooed personnel, and while it was not quite statistically significant in our study, the tendency was there, and was borne out by two other studies reported in the literature (4, 5). A distillation of the three groups examined is set forth in Figure 4. Further study of this factor could be of some importance, considering the traditional relationship between sailors and tattoos.

Comparisons of the incidence of anti-HAV and HBcAb in Cornwallis recruits and in the Margaree crew are given in Tables XI and XII, and of the relationship between the markers in both groups in Table XIII. It is interesting to note that while there was no significant rise in the percentage of HBcAb by age in the overall analysis, it was approximately doubled

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samples that may have a very low level of antibody, we feel that we may indeed have discovered a way to determine the degree of enhancement that ISG administration has on the base titer.

Information that we lack at present includes the size and the titer of the ISG dose that was administered to the subjects prior to their tour of duty. There seems to be a relationship between the size of the immunizing dose and the length of time that it is effective, so that any further studies along these lines should include that information. Another missing piece of information involves those personnel that were lost from the study due to medical and other repatriation. Why were they returned to Canada? Perhaps there was something that would have been of interest in this study had we received a blood sample taken before repatriation. A notation of the specific reason for early repatriation would have been helpful in the final analysis.

We propose that the study of the effect of ISG on the level of anti-HAV in the blood serum be continued with the following modification: the first blood be drawn before the administration of ISG, a second drawn 1 to 2 weeks following the ISG, and a third 5 to 6 months later. That would afford us a comparison of the base line for the individual, the effect of the immunizing dose at its (presumed) peak, and the effect following the point of presumed loss of protection. With the questions raised by Kark in his study of Israeli troops (3) in mind, perhaps it would be of value to follow these cases for an additional year to equal the time span covered in his extensive study. It could ultimately be of considerable value in that our troops do not carry the same degree of immunity to Hepatitis A as the native Israelis and are therefore at greater risk of contracting the disease when serving in high-risk areas. A chart of the time lines of the Cyprus and Golan studies and of the proposed study is outlined in Table X.

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paralleled that of the control group, but for the final 6-month period an unexpected protective effect reappeared among the ISG-treated group, creating a difference between protected and non-protected personnel with a p-factor of .043.

Kark states that Weiland (1), in his study of Swedish troops in Cyprus, came to the conclusion that ISG prophylaxis probably completely prevents seroconversion and the suggestion is made that further study is needed to elucidate the effect of exposure to Hepatitis A virus after ISG administration.

The serological study of the blood samples received from the troops arriving at CANLOG/Camp Ziounia was most interesting. The incidence of anti-HAV seroconversion was somewhat higher than was found among the Cyprus contingents, and the discovery of a number of odd results 's probably the result of the ISG. There were several reverse seroconversions, from weakly positive at first to weakly to moderately negative after 6 months, and that is consistent with the differences in the counts per minute as recorded by the scintillation counter for the first and second samples overall (see Table V). Among the results labelled "confused" (Table IV), we may have further cases of reverse seroconversion as well as negative to positive seroconversion, depending on whether or not the samples were switched at source.

There seems to have been no research done using the net counts per minute or the spectrophotometer readings for determining changes in the levels of anti-HAV in blood serum. All the quantitative work that has come to our attention is focused on the titer of anti-HAV in positive specimens or in the ISG used for immunization. In those determinations, the operative quantity is the % neutralization of the Hepatitis A antigen on the solid-state substrate. Since the method we have developed to determine any effect of ISG on the level of anti-HAV uses the same principle, albeit with

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to determine whether or not the difference was statistically significant). Within the scope of the overall Hepatitis A testing, however, we had a large group of males from CFB Valcartier (1248), and the resulting figures show Quebec province to have a slightly lower incidence of anti-HAV than our overall Canadian population. The present thought regarding the original high antibody level in the French-origin population at CFB Cornwallis is that it arose from rural New Brunswick and similar areas, and is more a function of the rural aspect than of the cultural. Within this group from St. Jean, we found no seroconversions, and the covering letter of August 10, 1983 from Dr. Mark Boucher (L.C.D.C., Ottawa) stated that all first sera were tested for Hepatitis B surface antigen and found negative.

The sera from the contingents travelling to Cyprus were originally intended for use in a study of the effect of immune serum globulin (ISG) on the levels of anti-HAV. The persons who drew the blood, however, were apparently not apprised of this goal, since the blood samples were taken before the ISG was administered, and, accordingly, there was no consistent difference found in the apparent amount of anti-HAV in the pre- and post-duty samples.

There was one seroconversion from negative to positive for anti-HAV in this group, which is consistent with the findings of Kark (3) in his extensive study of Israeli army inductees. It would be of interest to have this subject's medical records examined to determine whether or not this was a subclinical seroconversion like the one occurring at CFB Cornwallis, and when it occurred with reference to his receiving ISG. Kark's study (3), which included 23,447 service personnel, experienced only one seroconversion within the first 6 months (at 178 days after ISG), as compared with 13 in the control group that had not received ISG. This study, however, continued for an additional 12 months and yielded extremely interesting results. During the 6th to 12th months, the incidence of Hepatitis A in the study group

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Figure 2. The level of antibodies to the Hepatitis B core antigen, however, tends to remain fairly stable with increasing age, illustrating the divergent modes of transmission for the two viruses.

The increasing levels of anti-HAV with progressively less urbanized living (and more primitive sanitation facilities) emphasizes once more the importance of sanitation and personal hygiene in the prevention of the spread of this disease. The highest rates of immunity were observed in the Atlantic Provinces and Prairies/Northwest Territories, and on closer examination, where information was available, the concentration was seen to be in subjects coming from such areas as Newfoundland, Labrador, rural New Brunswick, Northwest Territories, and the Yukon. Indeed, for the few persons in our survey known to come from the two latter areas, the incidence of anti-HAV approaches 100% (Figures 1 and 3).

Table VIII gives the CFB Cornwallis results of both anti-HAV and anti-HBc testing by course. A question arises as to the reasons for the decreased rate of incidence for both forms of Hepatitis antibodies in 1982. There were fewer recruits taken in 1982, but that should not have affect the level of antibodies carried by the recruits. It should be noted that there was one suspected Hepatitis A-related death in the spring of 1982, but the victim was not among our subjects. Results of his serological tests are given in Table IX. The one seroconversion which we recorded was in course 8217.

The sera from CFB St. Jean were requested after it was discovered, from our anti-HAV CFB Cornwallis results, that a large proportion of those who were positive had surnames of French origin. When the limited population sample we received from CFB St. Jean was tested, we found the converse to be the case: these recruits show a considerably lower incidence of anti-HAV than do the CFB Cornwallis recruits. (There was, however, too small a sample

For Hepatitis B core antibodies which overall occurred in 10% of the population, the interesting MOC's were 71 (31.6%), 281 (30%) and 861 and 862 (31%). These groups accounted for 42 men with an average occurrence of 31%, leaving the remaining 184 men with a rate of 5.4%.

The 227 crewmen who responded to the questions regarding tattoos afforded the following observations: there was no relationship between tattooing and the presence of anti-HAV. Twenty-nine percent of the men with no tattoos had anti-HAV, and 35% were positive among those who are tattooed. In the case of Hepatitis B, however, only 7% of those not tattooed had core antibodies, while 16% of the tattooed subjects were anti-HBc positive. These latter figures, while not statistically significant ( $p=.06$ ), are close to significance and might easily become so with the arrival of information from other sources. The distribution of tattoos and of HBcAb and anti-HAV by age is shown in Table VI. Finally, the results were tabulated in order to determine the amount of crossover between the incidence of Hepatitis A antibodies and antibodies to Hepatitis B core antigen. The results are shown in Table VII.

#### DISCUSSION

The overall rate of 23.6% for the prevalence of antibodies to Hepatitis A virus, in comparison with the figures quoted by Weiland (1) in his comprehensive report of Hepatitis A literature, seems to put us on a par with Switzerland (23.9%), New York (24%), and West Germany (31.2%) for ages 20 to 29, as reported in the 1970's. A recent article from Britain written by Maj M.G. Braithwaite (2) places the Netherlands at 31% and West Germany at 36% for the same age group.

There is an almost perfect correlation between increasing age and the level of antibodies to Hepatitis A in our study. This is illustrated in

A positive correlation ( $p=.01$ ) was found between the presence of anti-HAV and the area of Canada from which the subjects came. The Atlantic Provinces were highest (41.8%) with Prairies/NWT closely following (36.4%) and the lowest at 13.5% and 14.3% respectively were Quebec and the West Coast. There was no correlation between Hepatitis B markers and geographical area.

There was a positive correlation ( $p=.002$ ) between the number of years military service and the presence of anti-HAV, but none for HBcAb. Previous service outside Canada/USA was not correlated with either form of Hepatitis, but previous tours of duty specifically to Portugal and the Mediterranean had a marked correlation ( $p=.0002$ ) with anti-HAV and significant correlation ( $p=.04$ ) with anti-HBc.

There was no correlation between rank and the presence of antibodies to Hepatitis A, but there was correlation ( $p=.02$ ) with HBcAb. Among the 12 Leading Seamen there was a 25% incidence of antibodies to Hepatitis B core antigen and among the 13 Master Corporals a rate of 30.8%, in comparison with 10% for the crew as a whole.

The analysis of military occupation (MOC) for the 226 with information available proved to be very interesting. Hepatitis A had a significant correlation with a p value of .02, and Hepatitis B core was significant with a p value of .045. Of interest in anti-HAV levels were communications (radar, radio, sonar) staff, with antibodies present in nearly 58% of the 26 crewman in MOCs 251, 252, 271 and 272 alone. Cooks and stewards (MOC 851 and 862) had an incidence of approximately 54%, while of the 7 Supply Techs (MOC 911), six had antibodies (85.7%). These categories include 49 men at an averaged incidence of 57%. The remaining 177 crewmembers account for 43, or an incidence of 24.3%.

C. No change in count (level of anti-HAV)

- a) Both samples NEGATIVE for HA antibodies: 0 cases
- b) Both samples POSITIVE for HA antibodies: 2 cases (1.5%)

A summary of the data is given in Table V.

5. CFS Alert

Of the 72 individuals, 28 were found to have anti-HAV in the first samples, for a prevalence rate of 38.9%. One subject, #70, was negative for anti-HAV in the first specimen, taken January 27, 1978, and positive in the second specimen, taken March 24, 1978, indicating that he had contracted the infection during that time period.

6. HMCS Margaree

Of the 251 subjects tested, 79 (31.5%) were positive for antibodies to Hepatitis A, and 25 (10.0%) were positive or equivocal for antibodies to Hepatitis B core antigen (HBcAb). Two of the subjects (0.8%) were positive for Hepatitis B surface antigen (HBsAg) in the first sample, but the index case, a 27-year-old cook, seroconverted to HBsAg negative by our second bleeding. The subject who remained HBsAg positive is a 23-year-old marine engineer and is presumed to be a carrier.

The mean age for this group was 28.1 years with a range of 19 to 50. The distribution of the age groups was quite even. There was a positive correlation ( $p=.03$ ) between increasing age and the presence of anti-HAV, but none for HBcAb. It was interesting to note, though, that of the eleven 19-year-olds in the survey, 4 (36.4%) had HBcAb, more than 3 times the rate for any other age group.

3. Cases #183 and 185 were initially bled the same day, so the bloods may have been interchanged. The same is true of #187 and #190.
4. Case #299, from whom the second sample was supposedly obtained March 23, had been bled on the same date as #287, which was anti-HAV positive and had no second specimen. (Case #305 has also a single positive sample, but was from the contingent arriving and departing two weeks later).

The test analysis of 130 pairs of sera with regard to the effect of recently-administered ISG on the counts per minute recorded during ABBOTT HAVAB-RIA testing yielded the following data:

A. Count (presumed level of anti-HAV) increased from 1st to 2nd bleeding

- i) Both samples NEGATIVE for HA antibodies: 80 cases
  - ii) Both samples POSITIVE for HA antibodies: 24 cases
- Total number of cases showing increase: 104 (80%)
- Increase 10% or less (margin of accuracy) i) 10  
ii) 10 = 20
- Increased (adjusted total): 84 (64.6%)
- Increased 10% or less: 20 (15.4%)

B. Count (presumed level of anti-HAV) decreased from 1st to 2nd bleeding

- i) Both samples NEGATIVE for HA antibodies: 9 cases
  - ii) Both samples POSITIVE for HA antibodies: 15 cases
- Total number of cases showing decrease: 24 (18.5%)
- Decrease 10% or less (margin of accuracy) i) 1  
ii) 3 = 4
- Decreased (adjusted total): 20 (15.4%)
- Decreased 10% or less: 4 (3.1%)



and a fairly even distribution between 20 and 39 years of age. Correlation between age and anti-HAV was excellent (see Figure 2). The two subjects who seroconverted were aged 22 and 32.

There was no correlation between anti-HAV and the geographical home area in this group, although the West Coast again tended to be lower than the rest of Canada.

In the two seroconverting subjects, the time elapsed between blood samples was 25 weeks. The group as a whole was sampled at intervals of 19 to 52 weeks, with 72% in the 24 to 26 week range. One of the seroconversions had come from CFB St. Jean, P.Q., and the other from CFB Esquimalt, B.C., both of which are in areas of low prevalence of Hepatitis A as indicated by our studies.

The two men who seroconverted were serving in the Golan Heights and had received their ISG before embarkation, 6 and 7 days prior to the first blood sample which was taken on the date of arrival in one case and one day following arrival in the other.

The nine cases which yielded odd results are shown in Table IV. They originate in four different rotations.

1. Case #41 had a strongly positive first sample and a strongly negative second. It could possibly have been confused with #63 from the same rotation, which had a strongly negative first sample and lacked a second.
2. Cases #163, 165 and 167 all were initially bled the same day. ID #166 was not used, so it is possible that #165 and #167 could have been interchanged at that time.

### 3. Cyprus

Of the 1379 persons tested for the presence of anti-HAV, 359 (26.0%) were positive, 2 (0.14%) gave equivocal results, and 1 (0.07%), and infantryman aged 18 years, was negative in the first and positive in the post-Cyprus sample. Analysis showed the mean age to be 23.9 years with a range from 17 to 53, 76% lying between 18 and 27 years of age. Correlation between age and the presence of anti-HAV was perfect ( $p=0$ ; see Figure 2).

The military occupation was available for only 352 of the subjects, and there was no correlation with anti-HAV. We did note, however, that in this group the only cook was negative and three of the seven (42.9%) health services personnel were positive for anti-HAV.

There was positive correlation ( $p=.02$ ) between the 5 geographical areas outlined by social insurance numbers and the presence of antibodies, with the highest level registered in the Atlantic Provinces (39.7%) and the lowest (14.8%) among those from the West Coast. The remainder hovered between 25.3 and 28.3 percent. The mean ages of the subjects from the different geographical areas were very similar, indicating that the differences in anti-HAV in this case were not due to age differences.

### 4. Golan Heights/Syria

Four hundred and thirty-eight persons were tested for anti-HAV in this group. Of these, 170 (38.8%) were positive, 1 (0.2%) was equivocal in the first and negative in the post-service specimen, 9 (2.1%) gave confused results, and 2 (0.5%) were negative in the first and positive in the second. The group of 9 "confused" results is discussed separately below.

The mean age in this group was 29.9 years with a range of 18 to 51

However, course time was shortened to 8 weeks in March 1982, which decreased the time interval between samples to 7 and 8 weeks in the 1982-83 groups. As there was only one seroconversion, this factor was of no significance.

2. CFB St. Jean

Of the 185 subjects tested, 18 were positive for anti-HAV, giving a prevalence rate of 9.7%. No seroconversions were observed in this group. In the male recruits 17 of 137 (11.0%) had antibodies to Hepatitis A, while only one of 30 (3.2%) female recruits were positive.

The mean age was 19.6 years with the greatest concentration (80.5%) between 17 and 21. There was no correlation between age and the presence of antibodies, although there appeared to be a tendency toward increasing levels with increasing age.

The geographic roots of these subjects as determined by the first three digits of the social insurance number indicated no correlation between background and the presence of antibodies, but this may be due to the small sampling group, as the percentage positive for the Province of Quebec was 8.6 while the representatives from the Atlantic Provinces and Ontario (the only other provinces represented) were 25% positive or more.

Of the 4 whose military occupation was listed as cook, none had antibodies to Hepatitis A. This was true also of the single representative of the medical/dental field.

As there were no seroconversions indicating exposure to the virus, the course length was of no significance.

home addresses of the subjects, but in the latter stages as geographical origins became a matter of interest, this information was included. For those lacking the information, the first three digits of the Social Insurance Number were used as a guide to their general home area. Of the 1846 persons for whom the information gave some indication of home area, 573 or 31.2% were from the Atlantic Provinces, 110 (5.9%) from Quebec, 751 (40.6%) from Ontario, 249 (13.6%) from the Prairie provinces and Northwest Territories, and 163 (8.8%) from British Columbia and Yukon. The distribution of anti-HAV by regions of Canada is outlined in Figure 1.

Of the 875 recruits for whom the information was received, 201 (23%) had made a significant change in residence during their lifetime prior to enlistment. There was a tendency for those who had made a significant move to have a higher frequency of anti-HAV (23.4%) than those who did not (17.8%). Some had come from as far away as the British Isles, France, Germany, Argentina, Uruguay, and Hong Kong, but there was no significant correlation with individual countries.

There were 583 for whom information was available on rural/urban living. There was a positive correlation ( $p=0.01$ ) between the prevalence rate of 16.7% for urban dwellers and 25.9% for rural.

Military occupational categories were given for all but 27 of the recruits. While there was no overall correlation with anti-HAV, it is of interest to note that cooks and stewards with prevalences of 25.6% and 22.2% respectively and health services personnel at 22.0% have a slightly higher rate than the group as a whole.

During the first months of the study, the training period at CFB Cornwallis was 10 weeks in length, and the time period between blood samples ranged from 9 weeks, normally, to 11 weeks over the Christmas holiday season.

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TABLE I Summary of Specimens Received

	Number of Samples Received	Pairs	Singles	Number of Persons in Study	Males	Females	Age Range	Mean Age	Inclusive Dates of Study Samples
CFB Cornwallis	3223	1372	479	1851	1208	643	17-30	19.3	19 July 1981 to July 1983
CFB St. Jean	370	185	0	185	154	31	17-25	19.6	01 November to 17 Januar
Cyprus	2177	798	581	1379	1379	0	17-53	23.9	28 August 19 to October 1
Golan Hts. (Syria)	799	361	77	438	438	0	18-51	29.9	04 January 1 to 17 Novemb
CFB Alert	157	70	2	72	72	0	unknown	unknown	25 November to 31 March
HMCS Margaree	474	223	28	251	251	0	19-50	28.1	19 August 15 to 16 July 1
TOTALS	7200	3009	1507	4176	3501	673			

is Received

id	Number of Persons in Study		Males	Females	Age Range	Mean Age	Inclusive Dates of Study Samples	Time Elapsed Between 1st and 2nd Sample
	Pairs	Singles						
1372	479	1851	1208	643	17-30	19.3	19 July 1981 to July 1983	7-11 weeks
185	0	185	154	31	17-25	19.6	01 November 1982 to 17 January 1983	4-7 weeks
798	581	1379	1379	0	17-53	23.9	28 August 1981 to October 1983	Group I 53 weeks Group II-III 35 weeks
661	77	438	438	0	18-51	29.9	04 January 1982 to 17 November 1983	19-52 weeks
70	2	72	72	0	unknown	unknown	25 November 1977 to 31 March 1978	5-16 weeks
223	28	251	251	0	19-50	23.1	19 August 1983 to 16 July 1984	17-47 weeks
3009	1167	4176	3501	673				

2

TABLE II Summary of Hepatitis A Test Results

	CFB Cornwallis	CFB St. Jean	Cyprus	HMS Margaree	Golan Hts/ Syria	CFB Alert
Mean Age	19.3 yrs	19.6 yrs	23.9 yrs	28.1 yrs	29.9 yrs	no data
Overall anti-HAV POSITIVE	number 333/1851 18.0	18/185 9.7	359/1379 26.0	79/251 31.5	170/438 38.8	28/72 38.9
Pre-duty anti-HAV POSITIVE	number 333/1841 18.0	18/185 9.7	322/1246 25.8	77/242 31.8	169/431 39.2	28/72 38.9
Equivocal results	4	0	1	0	9	0
Post-duty anti-HAV POSITIVE	number 244/1374 17.8	18/185 9.7	230/930 24.7	70/227 30.8	137/368 40.3	29/72 40.3
Equivocal results	2	0	0	0	9	0
SEROCONVERSIONS	1 ♂ → + age 17 rad. op.	none	1 ♂ → + age 18 infantry	none	2 ♂ → + ages 22 and 32 1 wk+ → ♂	1 ♂ → + no data



TABLE III Summary of tests used in primary screening under contract 8SG82-00092

ABBOTT HAVAB

a) RIA:	Cornwallis	3223	
	St. Jean	370	
	Cyprus	2177	
	Golan Hts.	799	
	Alert	157	
b) EIA:	HMCS Margaree	474	
			7200

ABBOTT CORZYME

	Cornwallis	3223	
	Margaree	474	
			3697

ABBOTT AUSZYME II

	Margaree	474	
			474

NUMBER OF SPECIMEN TESTS	11,371
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CONTROLS (approx. 5%)	569
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TOTAL NUMBER OF TESTS USED IN PRIMARY SCREENING	11,940
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TABLE IV Golan Heights/Syria: Cases giving confused results on repeated testing

Case Number	Number of Days Post-1SG First Sample Taken	First Serum		Weeks Elapsed 1st to 2nd Serum	Second Serum		Comments
		Result	Titre		Result	Titre	
41	4	+	(strong)	24	0	(strong)	May be sample 2 of case #63
163	3	±	1	25	+	> 100	1st blood drawn #166 not used; and #167 most 1 been interchang case #163 as a
165	8	+	300	24	0	(strong)	
167	3	±	1	25	+	200	
183	approx. 10	+	100	25	0	(strong)	1st samples may switched
185	approx. 10	±	1	25	+	100	
187	approx. 10	+	100	25	0	(strong)	1st samples may switched
190	approx. 10 (date not recorded)	0	(moderate)	25	+	100	
299	5	+	(weak)	26	0	(moderate)	retrograde serc case #319, due

Yria: Cases giving confused results on repeated testing

Days first seen	First Serum		Weeks Elapsed 1st to 2nd Serum	Second Serum		Comments
	Result	Titre		Result	Titre	
	+	(strong)	24	0	(strong)	May be sample 2 of case #63
	±	1	25	+	> 100	1st blood drawn same day; #166 not used; cases #165 and #167 most likely to have been interchanged, leaving case #163 as a seroconversion
	+	300	24	0	(strong)	
	±	1	25	+	200	
	+	100	25	0	(strong)	1st samples may have been switched
	±	1	25	+	100	
	+	100	25	0	(strong)	1st samples may have been switched
recorded)	0	(moderate)	25	+	100	
	+	(weak)	26	0	(moderate)	retrograde seroconversion as per case #319, due to ISG administration?

2

TABLE V Effect of ISG administration on  
presumed serum anti-HAV levels in  
130 C.A.F. personnel posted to  
Golan Heights/Syria

	Number	(%)
Increased		
> 10%	84	(64.6)
≤ 10%	20	(15.4)
Decreased		
> 10%	20	(15.4)
≤ 10%	4	(3.1)
Unchanged	2	(1.5)
	130	(100.0)

TABLE VI HMCS Margaree: Incidence of antibodies to hepatitis A, hepatitis B  
core antibodies and tattoos with regard to age

Age	anti-HAV		HBcAb		Tattoo	
	Number	Percent	Number	Percent	Number	Percent
19	2/11	18.2%	4/11	36.4%	5/10	50%
20-21	9/38	23.7%	1/38	2.6%	15/36	41.7%
22-23	6/35	17.1%	4/35	11.4%	9/34	26.5%
24-25	6/26	23.1%	3/26	11.5%	4/26	15.4%
26-29	11/31	35.5%	3/31	9.7%	8/26	30.8%
30-34	12/27	44.4%	1/27	3.7%	10/26	38.5%
35-39	10/20	50%	2/20	10%	12/19	63.2%
40-50	14/28	50%	2/28	7.1%	9/27	33.3%

TABLE VII HMCS Margaree: Relationship between the presence of antibodies to hepatitis A virus and antibodies to hepatitis B core antigen

	Number	Percent
No hepatitis antibodies	156	62.2
Anti-HAV alone	70	27.9
HBcAb alone	16	9.3
Both anti-HAV and HBcAb	9	3.6
Totals	251	100.00

TABLE VIII CFB Cornwallis: Results by course of testing recruits for Hepatitis antibodies 1981-1982

Course #	Course Length	Single	Pairs	Total	Pos. A	Pos. B	± B	Seroconversions
8129	9 wks.	38	84	122	17	6	2	2 (B)
8129W		12	48	60	7	4	0	4 (B)
8133	10 wks.	35	47	82	17	4	1	0
8133W		12	54	66	11	3	2	2 (B)
8137	9 wks.	29	66	95	18	4	0	0
8137W		16	73	89	22	6	0	2 (B)
8141	8½ wks.	43	73	116	28	3	1	1 (B)
8141W		24	79	103	21	4	1	1 (B)
8145	11 wks.	25	50	75	20	4	0	0
8145W		10	44	54	9	5	0	1(B)
		244	618	862	170 19.8%	43 5.0%	7 0.8%	Hep. A: 0(0.0%) Hep. B: 13(2.1%)
8201	9 wks.	28	73	101	13	0	0	0
8201W		20	69	89	14	3	0	0
8213	7 wks.	18	42	60	13	0	0	1 (B)
8213W		10	22	32	7	1	0	0
8217	7 wks.	21	58	79	10	0	0	1 (A)
8217W		2	50	52	8	0	0	1 (B)
8220	7 wks.	4	26	30	6	1	0	0
8220W		10	32	42	9	1	0	0
8223	7 wks.	24	79	102	22	3	0	0
8228	7 wks.	9	79	88	5	3	2	0
8233	7½ wks.	24	63	87	13	1	0	0
8244	9 wks.	26	52	78	11	1	0	0
8245	9 wks.	16	46	62	15	5	1	0
8245W		7	21	28	6	2	0	0
8248	9 wks.	9	22	31	2	6	0	0
8248W		5	23	28	2	0	0	0
		233	756	989	156 15.8%	27 2.7%	3 0.3%	Hep. A: 1(0.1%) Hep. B: 2(0.26%)

TABLE IX Summary of testing for hepatitis antibodies in  
fatal case 1982

Feb 10th, 1982 from CFB Greenwood:

HBAG (by RIA) Negative  
HBAB (by RIA) Negative  
Hepatitis A Antibody Negative

Feb 10th, 1982 from Canadian Forces Hospital, Halifax:

HBAG (by RIA) Negative  
HBAB (by RIA) Negative  
Hepatitis A Antibody Negative

Feb 16th, 1982 from Canadian Forces Hospital, Halifax:

HBAG (RIA) Negative  
HBAB (RIA) Negative

Feb 17th, 1982 from Canadian Forces Hospital, Halifax:

HBAG (RIA) Negative  
HBAB (RIA) Negative

Feb 18th, 1982 from Canadian Forces Hospital, Halifax:

Hepatitis A Antibody Positive 1/50 IgG Positive  
IgM Negative

(CONFIRMED BY TEST DONE AT ST. JOSEPH'S HOSPITAL, HAMILTON, ONT.)



TABLE X Time chart of Cyprus and Golan Heights: ISG administration

VALCARTIER I }	
WINNIPEG }	1st Blood/ISG Given/Embarkation/Duty/Repatriation/2nd Blood
VALCARTIER II }	
(10 to 13 months elapsed)	
No consistent difference in test results.	
GOLAN HEIGHTS/ SYRIA	ISG Given/Embarkation/1st Blood/Duty/2nd Blood/Repatriation
(6 months elapsed)	
Consistent difference found in test results.	
PROPOSED STUDY	1st Blood/ISG Given/1 to 2 weeks/2nd blood/6 months/3rd blood

TABLE XI Comparison of the occurrence of anti-HAV in Cornwallis recruits and in the crew of HMCS Margaree as related to military occupation

MOC#	Anti-HAV			
	Cornwallis Recruits		HMCS Margaree	
	(Number)	Percent	(Number)	Percent
1-99	(76/365)	20.8%	(13/49)	26.5%
100-199	(10/61)	16.4%	(3/13)	23.1%
200-299	(47/236)	19.9%	(21/60)	35.0%
300-399	(13/47)	27.7%	(11/55)	20.0%
400-499	(55/414)	13.3%	- none -	
500-599	(29/188)	15.4%	(5/11)	45.5%
600-699	(0/2)	0.0%	(0/3)	0.0%
700-799	(9/41)	22.0%	(0/1)	0.0%
800-800				
-less 861, 862	(25/152)	16.4%	(2/6)	33.3%
-861, 862 only	(33/135)	24.4%	(6/12)	50.0%
900-999	(29/181)	16.0%	(6/7)	87.5%
OVERALL	(338/1851)	18.0%	(79/251)	31.5%
	p = .03		p = .02	

TABLE XII Comparison of the occurrence of hepatitis B core antibodies in Cornwallis recruits as related to military occupation

MOC#	HBcAb			
	Cornwallis		HMCS Margaree	
	(Number)	Percent	(Number)	Percent
1-99	(19/365)	5.2%	(9/49)	18.4%
100-199	(2/61)	3.3%	(0/13)	0.0%
200-299	(5/236)	2.1%	(4/60)	6.7%
300-399	(2/47)	4.3%	(3/55)	5.5%
400-499	(20/414)	4.8%	- none -	
500-599	(9/188)	4.8%	(3/11)	27.3%
600-699	(0/2)	0.0%	(0/3)	0.0%
700-799	(3/41)	7.3%	(0/1)	0.0%
800-899				
-less 861, 862	(3/152)	2.0%	(0/6)	0.0%
-861, 862 only	(4/135)	3.0%	(3/12)	25.0%
900-999	(8/181)	4.4%	(0/7)	0.0%
OVERALL	(79/1849)	4.3%	(25/251)	10.0%

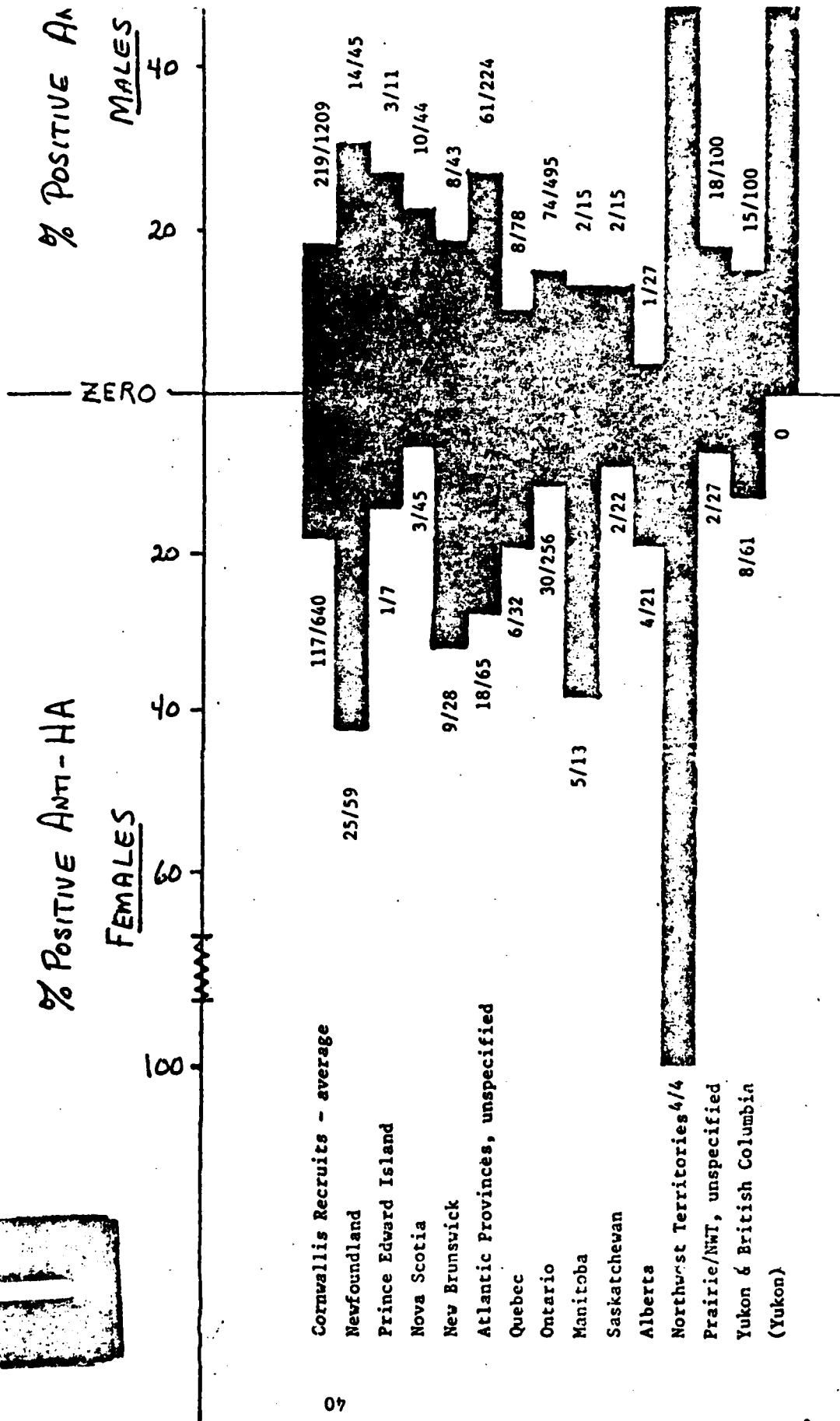
TABLE XIII Comparison of hepatitis A and hepatitis B core markers in  
CFB Cornwallis recruits and HMCS Margaree crew

Marker	Cornwallis		Margaree	
	(Number)	Percent	(Number)	Percent
Anti-HAV alone	(319)	17.3%	(70)	27.9%
Anti-HBc alone	(60)	3.2%	(16)	6.4%
Both anti-HAV and anti-HBc	(19)	1.0%	(9)	3.6%
Neither anti-HAV nor anti-HBc	(1451)	78.5%	(156)	62.2%

TABLE XIV Prevalence of Various Markers for Hepatitis B

Source	Anti-HBs and Anti-HBc		Anti-HBs alone		Anti-HBc alone	
	Number	%	Number	%	Number	%
Aircrew study <sup>7</sup>	53/1384	6.1	16	1.2	15	1.1
Canadian Forces Health Personnel <sup>6</sup>	17/624	3.0	37	6.0	5	0.8
US Army blood donors <sup>4</sup>	26/622	4.2	18	2.9	22	3.5
US Army blood donors <sup>5</sup> (Germany)	81/731	11.1	14	1.9	30	4.1

FIGURE 1 CFB CORNWALLIS RECRUITS: DISTRIBUTION OF ANTI-HAV BY PROVINCE AND GENDER 1981-1983



1 CFB CORNWALLIS RECRUITS: DISTRIBUTION OF ANTI-HAV BY PROVINCE AND GENDER 1981-1983

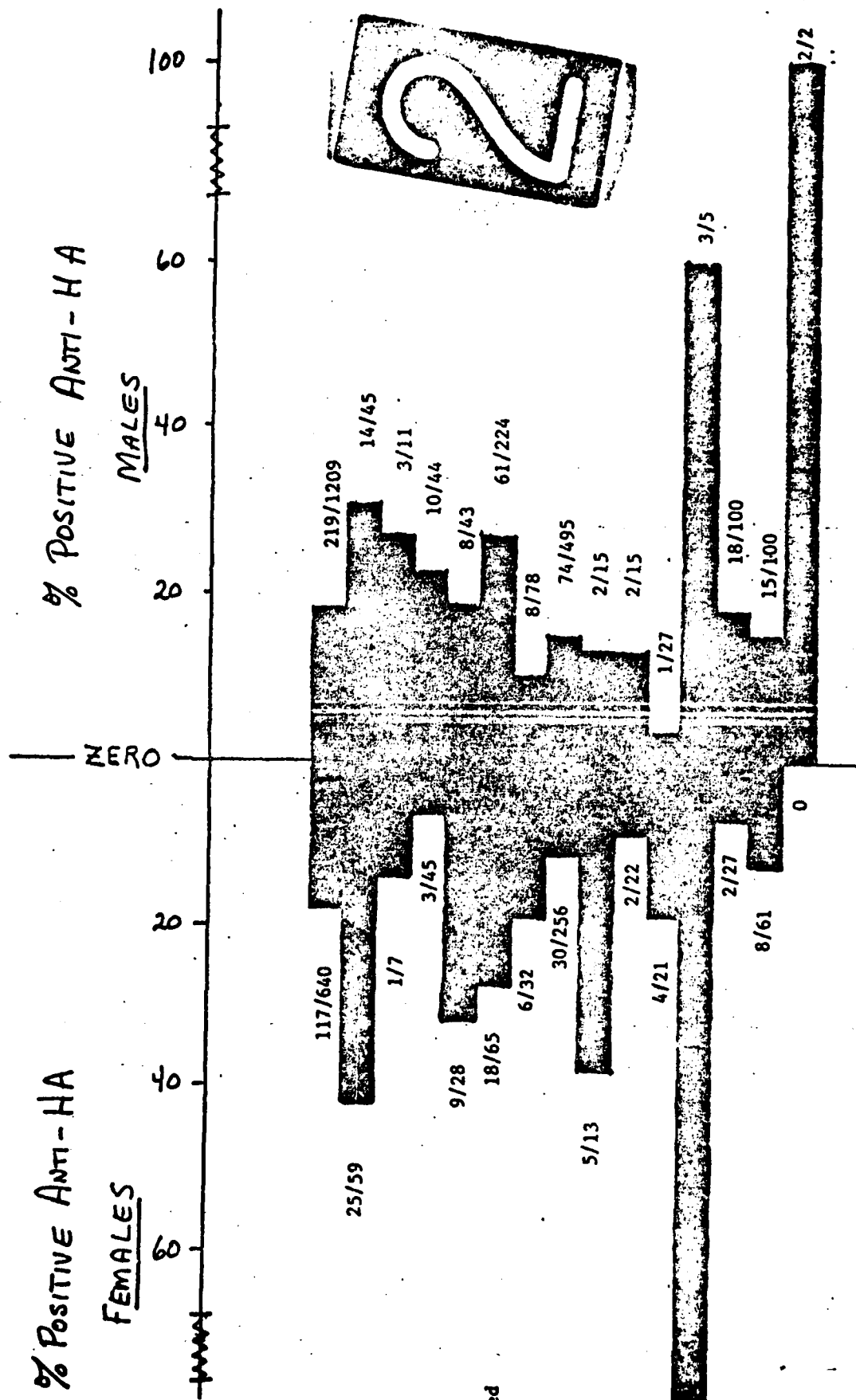


FIGURE 2 The relationship of age to the presence of antibodies to the hepatitis A virus in members of the Canadian Armed Forces 1981-1984

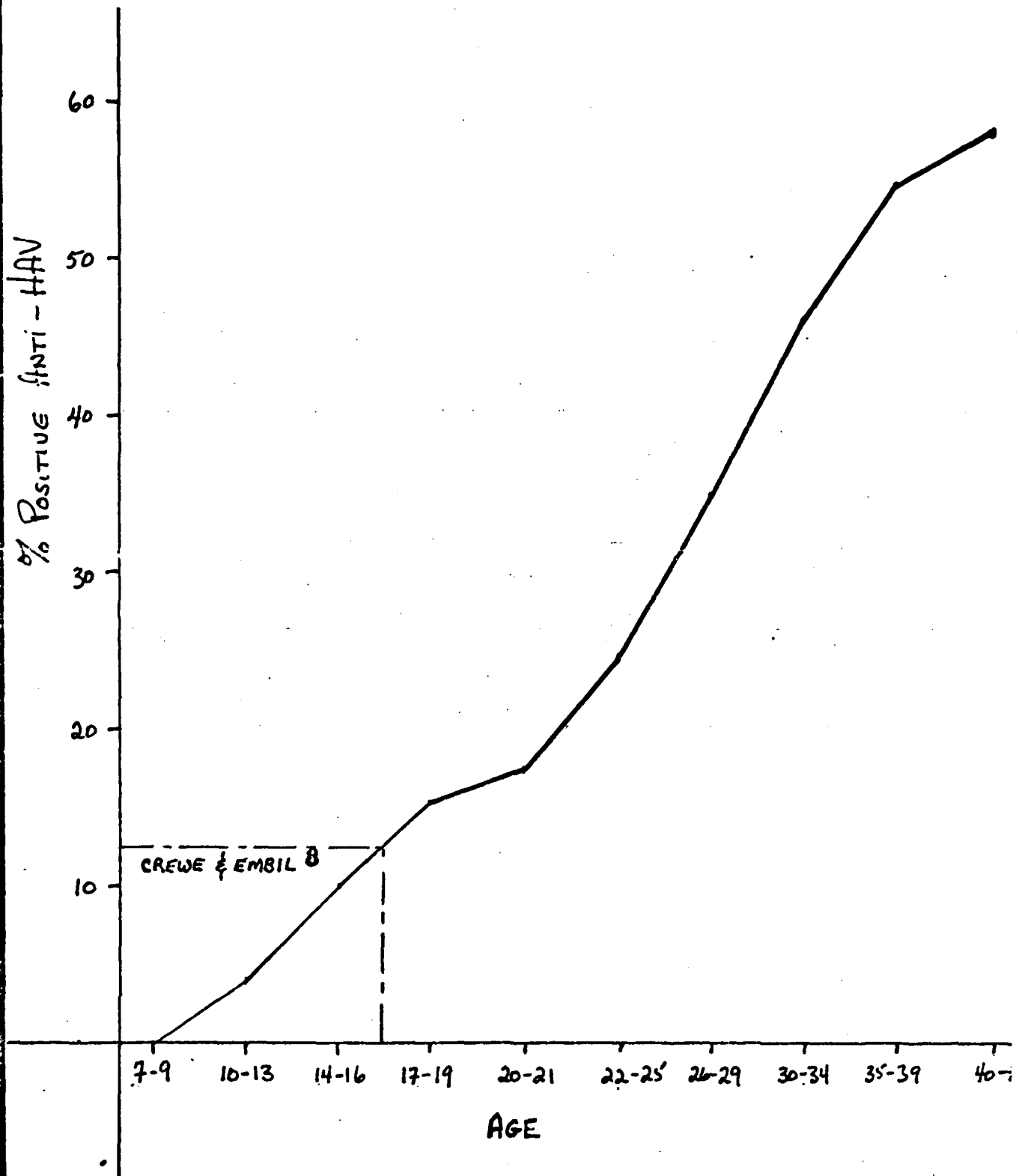




FIGURE 3 Geographical distribution of antibodies to hepatitis A virus and to hepatitis B core antigen in Canadian Armed Forces personnel 1981-1983

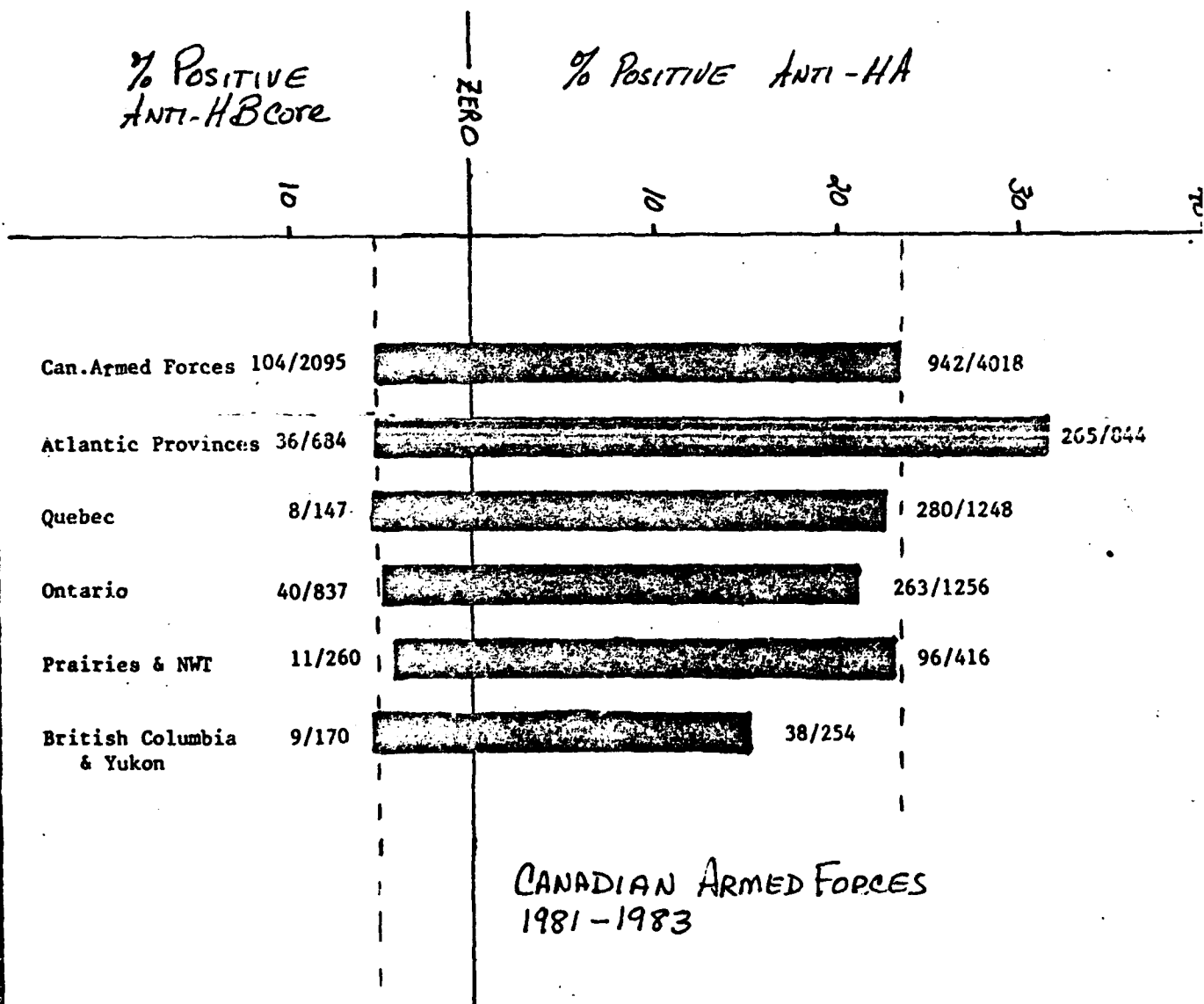
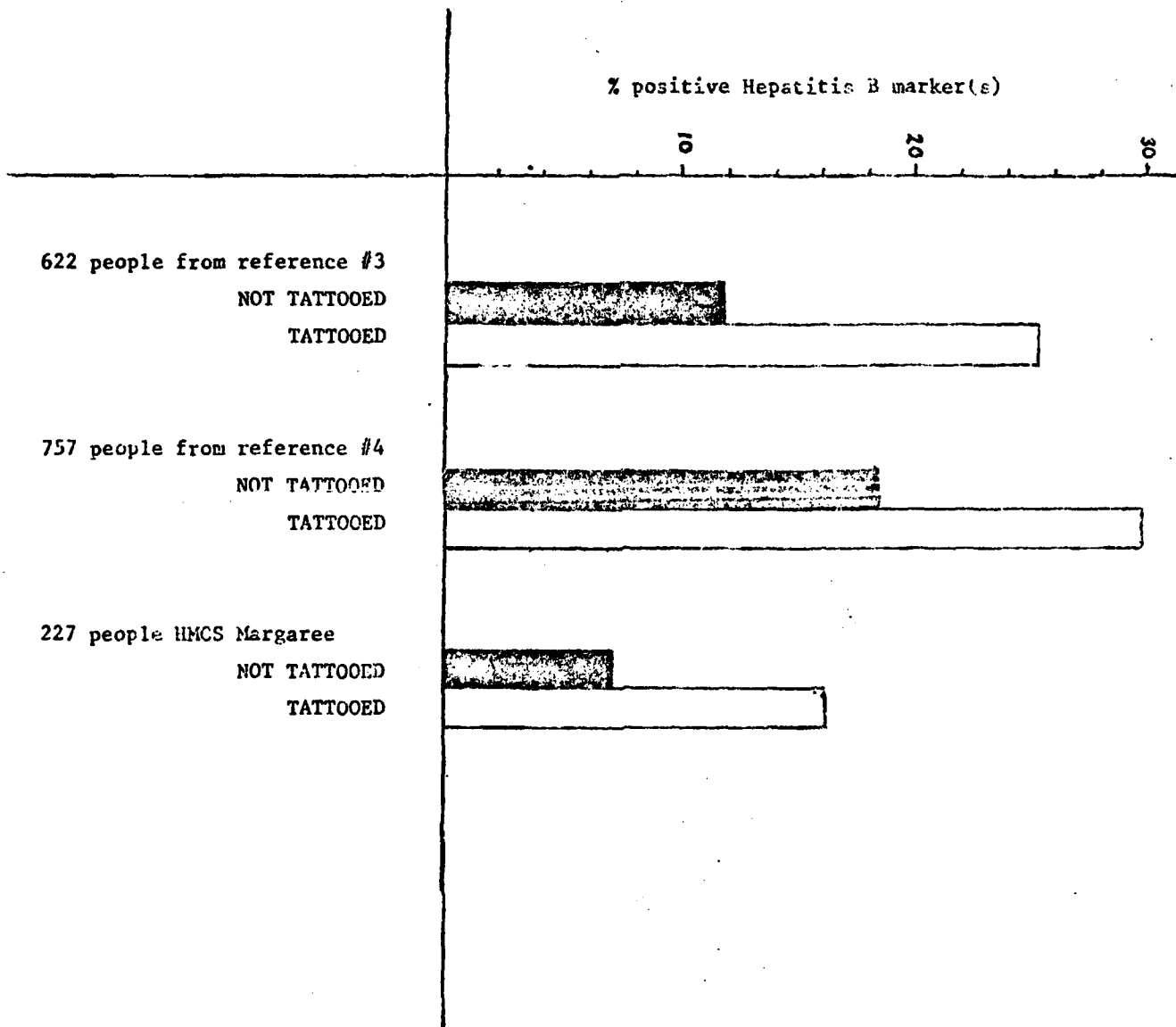


FIGURE 4 Comparison of the incidence of antibodies to hepatitis B in tattooed and non-tattooed individuals in three different military populations



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